

Praktikum Kecerdasan Buatan

Artificial Neural Networks: Multilayer Perceptron

Department of Information and Computer Engineering
Politeknik Elektronika Negeri Surabaya

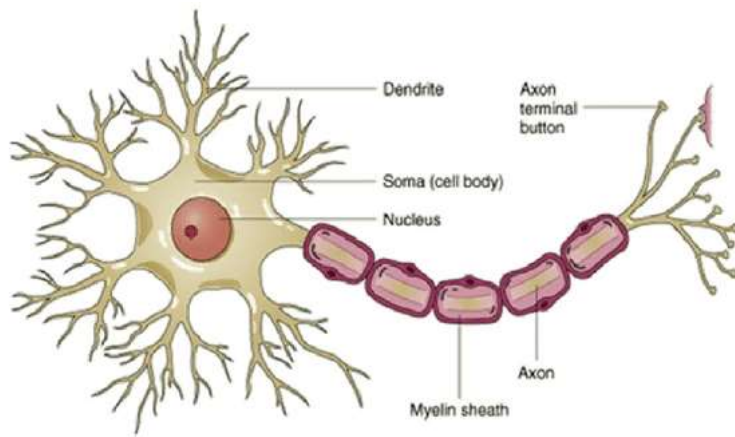


Politeknik Elektronika Negeri Surabaya
Departemen Teknik Informatika dan Komputer

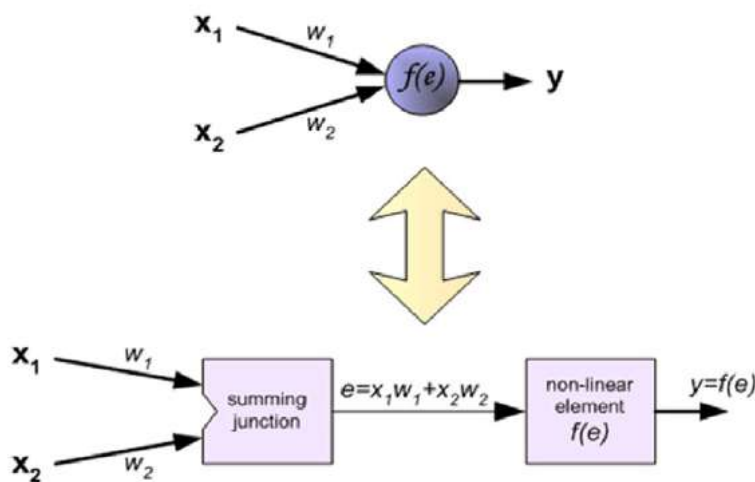
What's a Neural Network? (1)

A neural network is loosely based on how the human brain works:

- Many neurons connected to other neurons
- Passing information through their connections and firing when the input to a neuron surpasses a certain threshold.



(a) Biological neuron



(b) Artificial neural network

Artificial neural network will consist of:

- Artificial neurons and synapses with information being passed between them.
- The synapses, or connections, will be weighted according to the neuron's strength of influence on determining the output.
- These synaptic weights will go through an optimization process called **backpropagation**.
- For **each iteration during the training process**, backpropagation will be used to go back through the layers of the network and **adjusts the weights according to their contribution to the neural net's error**.

What's a Neural Network? (2)

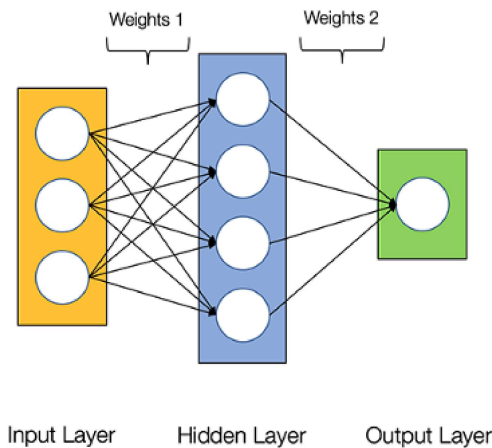
Neural Networks as a mathematical function that maps a given input to a desired output.

Neural Networks consist of the following components

- An **input layer**, x
- An arbitrary amount of **hidden layers**
- An **output layer**, \hat{y}
- A set of **weights** and **biases** between each layer, W and b
- A choice of **activation function** for each hidden layer, σ .

The diagram below shows the architecture of a 2-layer Neural Network

(Note that the input layer is typically excluded when counting the number of layers in a Neural Network)



Creating a Neural Network class

```
class NeuralNetwork:
    def __init__(self, x, y):
        self.input = x
        self.weights1 = np.random.rand(self.input.shape[1],4)
        self.weights2 = np.random.rand(4,1)
        self.y = y
        self.output = np.zeros(y.shape)
```

Training the Neural Network

Training the Neural Network $\hat{y} = \sigma(W_2 \sigma(W_1 x + b_1) + b_2)$

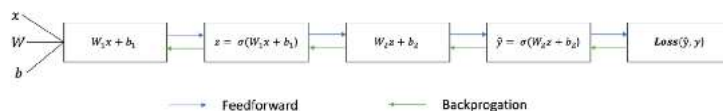
Notice that in the equation above, **the weights W and the biases b** are the only variables that affects the **output \hat{y}** .

Naturally, the right values for the weights and biases determines the strength of the predictions.

The process of fine-tuning the weights and biases from the input data is known as training the Neural Network.

Each iteration of the training process consists of the following steps:

- Calculating the predicted output \hat{y} , known as **feedforward**
- Updating the weights and biases, known as **backpropagation**



The sequential graph below illustrates the process.

Feedforward

Based on the sequential graph above, feedforward is just simple calculus and for a basic 2-layer neural network, the output of the Neural Network is:

$$\hat{y} = \sigma(W_2 \sigma(W_1 x + b_1) + b_2)$$

Let's add a feedforward function in our python code to do exactly that.

Note that for simplicity, we have assumed the biases to be 0.

Sigmoid is used as the activation function.

```
class NeuralNetwork:
    def __init__(self, x, y):
        self.input = x
        self.weights1 = np.random.rand(self.input.shape[1],4)
        self.weights2 = np.random.rand(4,1)
        self.y = y
        self.output = np.zeros(self.y.shape)

    def feedforward(self):
        self.layer1 = sigmoid(np.dot(self.input, self.weights1))
        self.output = sigmoid(np.dot(self.layer1, self.weights2))
```

However, we still need a way to evaluate the **"goodness"** of our predictions (i.e. how far off are our predictions)? The Loss Function allows us to do exactly that.

Loss Function

There are many available loss functions, and the nature of our problem should dictate our choice of loss function.

In this case, we'll use a simple **sum-of-squares error** as our loss function.

The sum-of-squares error is simply the sum of the difference between each predicted value and the actual value. The difference is squared so that we measure the absolute value of the difference.

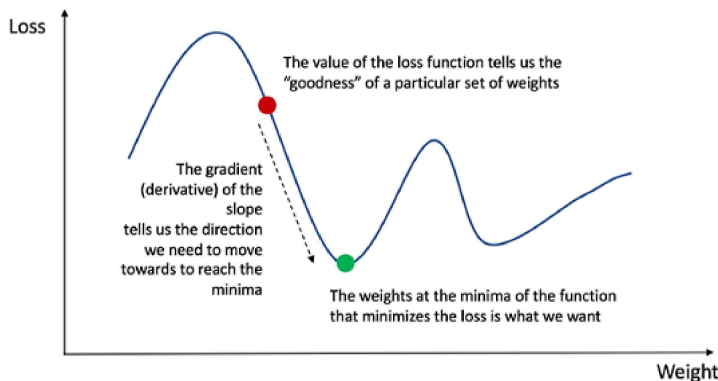
Our goal in training is to find the best set of weights and biases that minimizes the loss function.

Backpropagation

Now that we've measured the error of our prediction (loss), we need to find a way to propagate the error back, and to **update our weights and biases**.

In order to know the appropriate amount to adjust the weights and biases by, **we need to know the derivative of the loss function with respect to the weights and biases**.

Recall from calculus that the derivative of a function is simply the slope of the function.



If we have the derivative, we can simply **update the weights and biases by increasing/reducing with it** (refer to the diagram above). This is known as **gradient descent**.

However, we can't directly calculate the derivative of the loss function with respect to the weights and biases because the equation of the loss function does not contain the weights and biases. Therefore, we need the chain rule to help us calculate it.

$$\begin{aligned}
 \text{Loss}(y, \hat{y}) &= \sum_{i=1}^n (y - \hat{y})^2 \\
 \frac{\partial \text{Loss}(y, \hat{y})}{\partial W} &= \frac{\partial \text{Loss}(y, \hat{y})}{\partial \hat{y}} * \frac{\partial \hat{y}}{\partial z} * \frac{\partial z}{\partial W} \quad \text{where } z = Wx + b \\
 &= 2(y - \hat{y}) * \text{derivative of sigmoid function} * x \\
 &= 2(y - \hat{y}) * z(1-z) * x
 \end{aligned}$$

Now get what we needed — the derivative (slope) of the loss function with respect to the weights, so that we can adjust the weights accordingly.

Now that we have that, let's add the backpropagation function into our python code.

```

class NeuralNetwork:
    def __init__(self, x, y):
        self.input = x
        self.weights1 = np.random.rand(self.input.shape[1],4)
        self.weights2 = np.random.rand(4,1)
        self.y = y
        self.output = np.zeros(self.y.shape)

    def feedforward(self):
        self.layer1 = sigmoid(np.dot(self.input, self.weights1))
        self.output = sigmoid(np.dot(self.layer1, self.weights2))

    def backprop(self):
        # application of the chain rule to find derivative of the loss function with respect to weights2 and weights1
        d_weights2 = np.dot(self.layer1.T, (2*(self.y - self.output) * sigmoid_derivative(self.output)))
        d_weights1 = np.dot(self.input.T, (np.dot(2*(self.y - self.output) * sigmoid_derivative(self.output), self.weights2.T) * sigmoid
        # update the weights with the derivative (slope) of the loss function

```



```
self.weights1 += d_weights1
self.weights2 += d_weights2
```

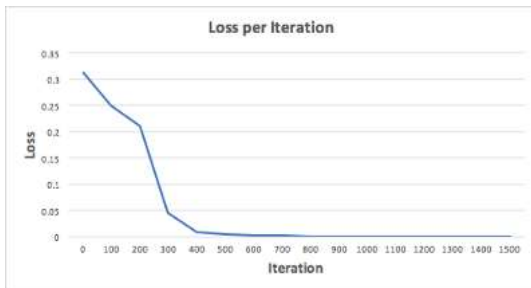
Putting it all together

Now that we have our complete python code for doing feedforward and backpropagation, let's apply our Neural Network on an example and see how well it does.

X1	X2	X3	Y
0	0	1	0
0	1	1	1
1	0	1	1
1	1	1	0

Our Neural Network should learn the ideal set of weights to represent this function. Note that it isn't exactly trivial for us to work out the weights just by inspection alone.

Let's train the Neural Network for 1500 iterations and see what happens. Looking at the loss per iteration graph below, we can clearly see the loss **monotonically decreasing towards a minimum**. This is consistent with the gradient descent algorithm that we've discussed earlier.



Let's look at the final prediction (output) from the Neural Network after 1500 iterations.

Prediction	Y (Actual)
0.023	0
0.979	1
0.975	1
0.025	0

We did it! Our feedforward and backpropagation algorithm trained the Neural Network successfully and the predictions converged on the true values.

Note that there's a slight difference between the predictions and the actual values. This is desirable, as it prevents overfitting and allows the Neural Network to generalize better to unseen data.

Referensi: <https://towardsdatascience.com/introduction-to-neural-networks-in-python-7e0b422e6c24>

```
# https://towardsdatascience.com/introduction-to-neural-networks-in-python-7e0b422e6c24
```

```
import numpy as np # helps with the math
import matplotlib.pyplot as plt # to plot error during training
```

```
# input data
```

```
inputs = np.array([[0, 1, 0],
                  [0, 1, 1],
                  [0, 0, 0],
                  [1, 0, 0],
                  [1, 1, 1],
                  [1, 0, 1]])
```

```
# output data
```

```
outputs = np.array([[0], [0], [0], [1], [1], [1]])
```

```
# create NeuralNetwork class
```

```
class NeuralNetwork:
```

```
    # initialize variables in class
```

```
    def __init__(self, inputs, outputs):
```

```
        self.inputs = inputs
```

```
        self.outputs = outputs
```

```
        # initialize weights as .50 for simplicity
```

```
        self.weights = np.array([[.50], [.50], [.50]])
```

```
        self.error_history = []
```

```
        self.epoch_list = []
```

```
    #activation function ==> S(x) = 1/(1+e^(-x))
```

```

def sigmoid(self, x, deriv=False):
    if deriv == True:
        return x * (1 - x)
    return 1 / (1 + np.exp(-x))

# data will flow through the neural network.
def feed_forward(self):
    self.hidden = self.sigmoid(np.dot(self.inputs, self.weights))

# going backwards through the network to update weights
def backpropagation(self):
    self.error = self.outputs - self.hidden
    delta = self.error * self.sigmoid(self.hidden, deriv=True)
    self.weights += np.dot(self.inputs.T, delta)

# train the neural net for 25,000 iterations
def train(self, epochs=25000):
    for epoch in range(epochs):
        # flow forward and produce an output
        self.feed_forward()
        # go back though the network to make corrections based on the output
        self.backpropagation()
        # keep track of the error history over each epoch
        self.error_history.append(np.average(np.abs(self.error)))
        self.epoch_list.append(epoch)

# function to predict output on new and unseen input data
def predict(self, new_input):
    prediction = self.sigmoid(np.dot(new_input, self.weights))
    return prediction

# create neural network
NN = NeuralNetwork(inputs, outputs)
# train neural network
NN.train()

# create two new examples to predict
example = np.array([[1, 1, 0]])
example_2 = np.array([[0, 1, 1]])

# print the predictions for both examples
print(NN.predict(example), ' - Correct: ', example[0][0])
print(NN.predict(example_2), ' - Correct: ', example_2[0][0])

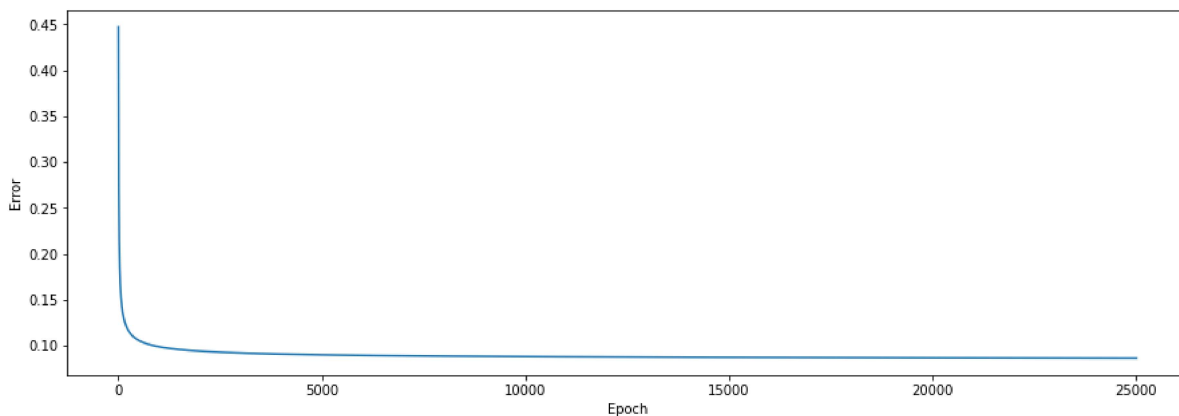
# plot the error over the entire training duration
plt.figure(figsize=(15,5))
plt.plot(NN.epoch_list, NN.error_history)
plt.xlabel('Epoch')
plt.ylabel('Error')
plt.show()

```

```

[[0.99089925]] - Correct: 1
[[0.006409]] - Correct: 0

```



```

# https://medium.com/@samuelsena/pengenalan-deep-learning-part-4-deep-learning-framework-introduction-tensorflow-keras-b8f00b146f06
import numpy as np
import matplotlib.pyplot as plt
import tensorflow as tf
from keras.models import Model, Sequential
from keras.layers import Input, Activation, Dense
from tensorflow.keras.optimizers import SGD

# Generate data from -20, -19.75, -19.5, ..., 20
train_x = np.arange(-20, 20, 0.25)

```

```
# Calculate Target :  $\sqrt{2x^2 + 1}$ 
train_y = np.sqrt((2*train_x**2)+1)

# Create Network
inputs = Input(shape=(1,))
h_layer = Dense(8, activation='relu')(inputs)
h_layer = Dense(4, activation='relu')(h_layer)
outputs = Dense(1, activation='linear')(h_layer)
model = Model(inputs=inputs, outputs=outputs)

# Optimizer / Update Rule
sgd = SGD(lr=0.001)
# Compile the model with Mean Squared Error Loss
model.compile(optimizer=sgd, loss='mse')

# Train the network and save the weights after training
model.fit(train_x, train_y, batch_size=20, epochs=10000, verbose=1)
model.save_weights('weights.h5')

# Predict training data
predict = model.predict(np.array([26]))
print('f(26) = ', predict)

predict_y = model.predict(train_x)

# Draw target vs prediction
plt.plot(train_x, train_y, 'r')
plt.plot(train_x, predict_y, 'b')
plt.show()
```

```
Epoch 1/10000
/usr/local/lib/python3.7/dist-packages/keras/optimizer_v2/gradient_descent.py:102: UserWarning: The `lr` argument is deprecated, use
    super(SGD, self).__init__(name, **kwargs)
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8/8 [=====] - 0s 2ms/step - loss: 0.0018
Epoch 7633/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0018
Epoch 7634/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0018
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Epoch 7635/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0018
Epoch 7636/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0018
Epoch 7637/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0018
Epoch 7638/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0018
Epoch 7639/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0018
Epoch 7640/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0018
Epoch 7641/10000
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Epoch 7650/10000
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Epoch 7651/10000
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Epoch 7655/10000
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Epoch 7659/10000
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Epoch 7660/10000
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Epoch 7661/10000
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Epoch 7662/10000
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Epoch 7663/10000
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Epoch 7664/10000
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Epoch 7665/10000
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Epoch 7666/10000
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Epoch 7667/10000
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Epoch 7668/10000
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Epoch 7669/10000
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Epoch 7670/10000
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Epoch 7671/10000
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Epoch 7672/10000
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Epoch 7673/10000
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Epoch 7674/10000
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Epoch 7675/10000
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Epoch 7676/10000
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Epoch 7677/10000
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Epoch 7678/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0018
Epoch 7679/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0018
Epoch 7680/10000
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Epoch 7680/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0018
Epoch 7681/10000
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Epoch 7682/10000
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Epoch 7683/10000
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Epoch 7684/10000
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Epoch 7685/10000
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Epoch 7686/10000
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Epoch 7687/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0018
Epoch 7688/10000
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Epoch 7689/10000
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Epoch 7690/10000
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Epoch 7691/10000
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Epoch 7692/10000
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Epoch 7698/10000
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Epoch 7699/10000
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Epoch 7700/10000
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Epoch 7701/10000
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Epoch 7702/10000
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Epoch 7703/10000
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Epoch 7704/10000
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Epoch 7705/10000
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Epoch 7706/10000
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Epoch 7707/10000
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Epoch 7709/10000
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Epoch 7716/10000
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Epoch 7722/10000
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Epoch 7723/10000
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Epoch 7724/10000
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Epoch 7725/10000
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8/8 [=====] - 0s 2ms/step - loss: 0.0017
Epoch 7726/10000
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Epoch 7727/10000
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Epoch 7728/10000
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Epoch 7729/10000
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Epoch 7730/10000
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Epoch 7731/10000
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Epoch 7733/10000
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Epoch 7742/10000
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Epoch 7750/10000
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Epoch 7751/10000
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Epoch 7759/10000
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Epoch 7760/10000
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Epoch 7761/10000
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Epoch 7762/10000
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Epoch 7763/10000
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Epoch 7764/10000
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Epoch 7770/10000
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Epoch 7771/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0017
Epoch 7772/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0017
Epoch 7773/10000
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Epoch 7774/10000
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Epoch 7775/10000
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Epoch 7776/10000
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Epoch 7777/10000
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Epoch 7778/10000
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Epoch 7779/10000
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Epoch 7780/10000
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Epoch 7781/10000
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Epoch 7782/10000
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Epoch 7783/10000
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Epoch 7784/10000
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Epoch 7786/10000
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Epoch 7787/10000
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Epoch 7799/10000
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Epoch 7800/10000
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Epoch 7801/10000
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Epoch 7802/10000
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Epoch 7803/10000
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Epoch 7809/10000
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Epoch 7810/10000
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Epoch 7811/10000
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Epoch 7815/10000
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Epoch 7816/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0017
Epoch 7817/10000
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Epoch 7818/10000
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Epoch 7819/10000
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Epoch 7822/10000
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Epoch 7823/10000
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Epoch 7825/10000
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Epoch 7826/10000
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Epoch 7827/10000
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Epoch 7828/10000
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Epoch 7832/10000
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Epoch 7833/10000
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Epoch 7834/10000
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Epoch 7835/10000
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Epoch 7836/10000
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Epoch 7837/10000
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Epoch 7838/10000
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Epoch 7839/10000
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Epoch 7840/10000
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Epoch 7841/10000
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Epoch 7842/10000
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Epoch 7843/10000
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Epoch 7844/10000
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Epoch 7845/10000
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Epoch 7846/10000
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Epoch 7847/10000
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Epoch 7848/10000
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Epoch 7849/10000
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Epoch 7850/10000
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Epoch 7851/10000
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Epoch 7852/10000
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Epoch 7853/10000
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Epoch 7854/10000
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Epoch 7855/10000
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Epoch 7856/10000
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Epoch 7857/10000
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Epoch 7858/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0016
Epoch 7859/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0017
Epoch 7860/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0017
Epoch 7861/10000
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Epoch 7861/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0017
Epoch 7862/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0017
Epoch 7863/10000
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Epoch 7864/10000
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Epoch 7865/10000
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Epoch 7866/10000
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Epoch 7867/10000
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Epoch 7868/10000
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Epoch 7869/10000
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Epoch 7870/10000
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Epoch 7871/10000
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Epoch 7872/10000
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Epoch 7873/10000
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Epoch 7874/10000
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Epoch 7875/10000
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Epoch 7876/10000
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Epoch 7877/10000
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Epoch 7878/10000
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Epoch 7879/10000
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Epoch 7880/10000
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Epoch 7881/10000
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Epoch 7882/10000
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Epoch 7883/10000
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Epoch 7884/10000
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Epoch 7886/10000
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Epoch 7888/10000
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Epoch 7889/10000
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Epoch 7890/10000
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Epoch 7891/10000
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Epoch 7892/10000
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Epoch 7894/10000
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Epoch 7895/10000
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Epoch 7896/10000
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Epoch 7897/10000
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Epoch 7898/10000
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Epoch 7899/10000
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Epoch 7900/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0016
Epoch 7901/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0017
Epoch 7902/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0016
Epoch 7903/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0016
Epoch 7904/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0017
Epoch 7905/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0016
Epoch 7906/10000
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8/8 [=====] - 0s 2ms/step - loss: 0.0016
Epoch 7907/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0016
Epoch 7908/10000
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Epoch 7909/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0016
Epoch 7910/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0016
Epoch 7911/10000
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Epoch 7912/10000
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Epoch 7951/10000
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Epoch 7952/10000
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Epoch 8041/10000
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Epoch 8042/10000
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Epoch 8119/10000
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Epoch 8133/10000
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Epoch 8190/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0015
Epoch 8191/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0015
Epoch 8192/10000
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Epoch 8200/10000
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Epoch 8201/10000
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Epoch 8221/10000
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Epoch 8222/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0015
Epoch 8223/10000
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Epoch 8223/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0015
Epoch 8224/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0015
Epoch 8225/10000
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Epoch 8226/10000
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Epoch 8230/10000
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Epoch 8300/10000
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Epoch 8301/10000
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Epoch 8314/10000
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Epoch 8358/10000
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Epoch 8359/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0015
Epoch 8360/10000
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Epoch 8364/10000
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Epoch 8380/10000
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Epoch 8404/10000
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Epoch 8404/10000
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Epoch 8407/10000
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Epoch 8409/10000
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Epoch 8414/10000
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Epoch 8415/10000
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Epoch 8416/10000
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Epoch 8449/10000
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8/8 [=====] - 0s 2ms/step - loss: 0.0014
Epoch 8450/10000
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Epoch 8459/10000
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Epoch 8460/10000
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Epoch 8461/10000
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Epoch 8462/10000
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Epoch 8463/10000
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Epoch 8464/10000
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Epoch 8466/10000
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Epoch 8469/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0014
Epoch 8470/10000
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Epoch 8749/10000
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Epoch 8750/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0014
Epoch 8751/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8752/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8753/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0014
Epoch 8754/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8755/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8756/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0014
Epoch 8757/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8758/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0014
Epoch 8759/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8760/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8761/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0014
Epoch 8762/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0014
Epoch 8763/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0014
Epoch 8764/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0014
Epoch 8765/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0014
Epoch 8766/10000
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Epoch 8766/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8767/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0014
Epoch 8768/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8769/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0014
Epoch 8770/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8771/10000
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Epoch 8772/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8773/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0014
Epoch 8774/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0014
Epoch 8775/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0014
Epoch 8776/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0014
Epoch 8777/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8778/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8779/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0013
Epoch 8780/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8781/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0014
Epoch 8782/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8783/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8784/10000
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Epoch 8785/10000
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Epoch 8786/10000
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Epoch 8787/10000
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Epoch 8788/10000
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Epoch 8789/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0014
Epoch 8790/10000
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Epoch 8791/10000
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Epoch 8792/10000
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Epoch 8793/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8794/10000
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Epoch 8795/10000
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Epoch 8796/10000
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Epoch 8797/10000
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Epoch 8798/10000
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Epoch 8799/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8800/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0013
Epoch 8801/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8802/10000
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Epoch 8803/10000
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Epoch 8804/10000
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Epoch 8805/10000
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Epoch 8806/10000
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Epoch 8807/10000
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Epoch 8808/10000
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Epoch 8809/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0013
Epoch 8810/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8811/10000
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8/8 [=====] - 0s 3ms/step - loss: 0.0014
Epoch 8812/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 8813/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0013
Epoch 8814/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0013
Epoch 8815/10000
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Epoch 8816/10000
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Epoch 8817/10000
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Epoch 8818/10000
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Epoch 8819/10000
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Epoch 8820/10000
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Epoch 8821/10000
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Epoch 8822/10000
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Epoch 8823/10000
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Epoch 8824/10000
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Epoch 8825/10000
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Epoch 8826/10000
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Epoch 8827/10000
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Epoch 8828/10000
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Epoch 8829/10000
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Epoch 8830/10000
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Epoch 8831/10000
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Epoch 8832/10000
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Epoch 8833/10000
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Epoch 8834/10000
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Epoch 8835/10000
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Epoch 8836/10000
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Epoch 8837/10000
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Epoch 8838/10000
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Epoch 8839/10000
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Epoch 8840/10000
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Epoch 8841/10000
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Epoch 8842/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 8843/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0014
Epoch 8844/10000
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Epoch 8845/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0013
Epoch 8846/10000
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Epoch 8847/10000
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Epoch 8848/10000
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Epoch 8849/10000
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Epoch 8850/10000
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Epoch 8851/10000
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Epoch 8852/10000
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Epoch 8853/10000
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Epoch 8854/10000
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Epoch 8855/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 8856/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
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Epoch 8857/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 8858/10000
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Epoch 8859/10000
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Epoch 8860/10000
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Epoch 8861/10000
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Epoch 8862/10000
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Epoch 8863/10000
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Epoch 8864/10000
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Epoch 8865/10000
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Epoch 8866/10000
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Epoch 8867/10000
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Epoch 8868/10000
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Epoch 8869/10000
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Epoch 8870/10000
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Epoch 8871/10000
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Epoch 8872/10000
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Epoch 8874/10000
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Epoch 8875/10000
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Epoch 8876/10000
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Epoch 8877/10000
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Epoch 8878/10000
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Epoch 8879/10000
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Epoch 8880/10000
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Epoch 8881/10000
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Epoch 8890/10000
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Epoch 8891/10000
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Epoch 8892/10000
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Epoch 8893/10000
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Epoch 8895/10000
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Epoch 8896/10000
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Epoch 8897/10000
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Epoch 8898/10000
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Epoch 8899/10000
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Epoch 8900/10000
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Epoch 8901/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
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Epoch 8902/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0013
Epoch 8903/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 8904/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 8905/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0014
Epoch 8906/10000
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Epoch 8907/10000
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Epoch 8908/10000
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Epoch 8909/10000
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Epoch 8910/10000
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Epoch 8911/10000
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Epoch 8912/10000
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Epoch 8913/10000
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Epoch 8919/10000
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Epoch 8921/10000
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Epoch 8922/10000
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Epoch 8923/10000
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Epoch 8927/10000
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Epoch 8929/10000
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Epoch 8931/10000
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Epoch 8932/10000
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Epoch 8933/10000
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Epoch 8934/10000
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Epoch 8935/10000
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Epoch 8936/10000
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Epoch 8939/10000
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Epoch 8941/10000
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Epoch 8942/10000
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Epoch 8943/10000
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Epoch 8944/10000
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Epoch 8945/10000
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Epoch 8946/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0013
Epoch 8947/10000
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Epoch 8947/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0013
Epoch 8948/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 8949/10000
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Epoch 8950/10000
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Epoch 8951/10000
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Epoch 8952/10000
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Epoch 8953/10000
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Epoch 8954/10000
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Epoch 8955/10000
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Epoch 8956/10000
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Epoch 8957/10000
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Epoch 8958/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0013
Epoch 8959/10000
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Epoch 8960/10000
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Epoch 8961/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0013
Epoch 8962/10000
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Epoch 8963/10000
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Epoch 8964/10000
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Epoch 8965/10000
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Epoch 8966/10000
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Epoch 8967/10000
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Epoch 8968/10000
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Epoch 8969/10000
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Epoch 8970/10000
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Epoch 8971/10000
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Epoch 8972/10000
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Epoch 8973/10000
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Epoch 8974/10000
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Epoch 8975/10000
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Epoch 8976/10000
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Epoch 8977/10000
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Epoch 8978/10000
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Epoch 8979/10000
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Epoch 8980/10000
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Epoch 8981/10000
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Epoch 8982/10000
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Epoch 8983/10000
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Epoch 8984/10000
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Epoch 8985/10000
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Epoch 8986/10000
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Epoch 8987/10000
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Epoch 8988/10000
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Epoch 8989/10000
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Epoch 8990/10000
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Epoch 8991/10000
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Epoch 8992/10000
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8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 8993/10000
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Epoch 8994/10000
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Epoch 8995/10000
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Epoch 8996/10000
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Epoch 8997/10000
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Epoch 8998/10000
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Epoch 8999/10000
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Epoch 9000/10000
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Epoch 9001/10000
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Epoch 9002/10000
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Epoch 9003/10000
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Epoch 9004/10000
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Epoch 9005/10000
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Epoch 9006/10000
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Epoch 9007/10000
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Epoch 9008/10000
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Epoch 9009/10000
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Epoch 9010/10000
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Epoch 9011/10000
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Epoch 9012/10000
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Epoch 9013/10000
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Epoch 9014/10000
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Epoch 9018/10000
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Epoch 9020/10000
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Epoch 9028/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 9029/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 9030/10000
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Epoch 9031/10000
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Epoch 9032/10000
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Epoch 9036/10000
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Epoch 9037/10000
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Epoch 9038/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 9039/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0013
Epoch 9040/10000
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Epoch 9041/10000
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Epoch 9042/10000
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Epoch 9043/10000
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Epoch 9044/10000
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Epoch 9046/10000
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Epoch 9047/10000
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Epoch 9048/10000
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Epoch 9062/10000
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Epoch 9064/10000
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Epoch 9083/10000
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Epoch 9128/10000
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Epoch 9218/10000
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Epoch 9219/10000
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Epoch 9264/10000
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8/8 [=====] - 0s 3ms/step - loss: 0.0013
Epoch 9308/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9309/10000
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Epoch 9307/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 9310/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9311/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 9312/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 9313/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 9314/10000
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Epoch 9315/10000
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Epoch 9316/10000
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Epoch 9317/10000
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Epoch 9318/10000
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Epoch 9319/10000
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Epoch 9320/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 9321/10000
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Epoch 9322/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9323/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 9324/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 9325/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0013
Epoch 9326/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0013
Epoch 9327/10000
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Epoch 9328/10000
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Epoch 9329/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 9330/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 9331/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 9332/10000
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Epoch 9333/10000
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Epoch 9336/10000
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Epoch 9337/10000
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Epoch 9338/10000
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Epoch 9339/10000
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Epoch 9340/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 9341/10000
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Epoch 9342/10000
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Epoch 9346/10000
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Epoch 9348/10000
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Epoch 9349/10000
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Epoch 9350/10000
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Epoch 9351/10000
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Epoch 9352/10000
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Epoch 9353/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 9354/10000
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8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9355/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0013
Epoch 9356/10000
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Epoch 9357/10000
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Epoch 9358/10000
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Epoch 9359/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9360/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9361/10000
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Epoch 9362/10000
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Epoch 9363/10000
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Epoch 9364/10000
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Epoch 9365/10000
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Epoch 9371/10000
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Epoch 9372/10000
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Epoch 9379/10000
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Epoch 9380/10000
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Epoch 9381/10000
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Epoch 9382/10000
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Epoch 9388/10000
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Epoch 9398/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9399/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
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0/0 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9400/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9401/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9402/10000
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Epoch 9403/10000
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Epoch 9404/10000
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Epoch 9405/10000
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Epoch 9406/10000
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Epoch 9407/10000
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Epoch 9408/10000
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Epoch 9409/10000
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Epoch 9410/10000
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Epoch 9411/10000
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Epoch 9440/10000
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Epoch 9441/10000
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8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9444/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
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Epoch 9445/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9446/10000
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Epoch 9447/10000
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Epoch 9448/10000
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Epoch 9449/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9450/10000
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Epoch 9451/10000
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Epoch 9458/10000
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Epoch 9459/10000
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Epoch 9460/10000
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Epoch 9461/10000
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Epoch 9462/10000
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Epoch 9463/10000
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Epoch 9464/10000
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Epoch 9465/10000
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Epoch 9466/10000
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Epoch 9467/10000
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Epoch 9468/10000
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Epoch 9469/10000
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Epoch 9470/10000
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Epoch 9471/10000
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Epoch 9472/10000
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Epoch 9473/10000
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Epoch 9474/10000
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Epoch 9475/10000
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Epoch 9476/10000
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Epoch 9477/10000
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Epoch 9478/10000
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Epoch 9479/10000
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Epoch 9480/10000
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Epoch 9481/10000
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Epoch 9482/10000
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Epoch 9483/10000
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Epoch 9484/10000
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Epoch 9485/10000
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Epoch 9486/10000
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Epoch 9487/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9488/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9489/10000
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Epoch 9490/10000
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Epoch 9490/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9491/10000
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Epoch 9495/10000
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Epoch 9496/10000
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Epoch 9497/10000
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Epoch 9498/10000
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Epoch 9499/10000
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Epoch 9500/10000
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Epoch 9501/10000
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Epoch 9502/10000
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Epoch 9503/10000
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Epoch 9505/10000
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Epoch 9506/10000
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Epoch 9507/10000
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Epoch 9508/10000
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Epoch 9509/10000
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Epoch 9510/10000
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Epoch 9511/10000
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Epoch 9512/10000
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Epoch 9513/10000
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Epoch 9514/10000
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Epoch 9515/10000
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Epoch 9516/10000
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Epoch 9517/10000
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Epoch 9518/10000
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Epoch 9519/10000
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Epoch 9520/10000
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Epoch 9521/10000
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Epoch 9522/10000
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Epoch 9523/10000
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Epoch 9524/10000
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Epoch 9526/10000
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Epoch 9527/10000
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Epoch 9529/10000
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Epoch 9530/10000
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Epoch 9531/10000
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Epoch 9532/10000
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Epoch 9533/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9534/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9535/10000
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8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9536/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9537/10000
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Epoch 9538/10000
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Epoch 9539/10000
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Epoch 9540/10000
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Epoch 9541/10000
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Epoch 9542/10000
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Epoch 9543/10000
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Epoch 9544/10000
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Epoch 9545/10000
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Epoch 9546/10000
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Epoch 9547/10000
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Epoch 9548/10000
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Epoch 9549/10000
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Epoch 9550/10000
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Epoch 9551/10000
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Epoch 9552/10000
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Epoch 9553/10000
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Epoch 9554/10000
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Epoch 9558/10000
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Epoch 9559/10000
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Epoch 9560/10000
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Epoch 9561/10000
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Epoch 9562/10000
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Epoch 9563/10000
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Epoch 9564/10000
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Epoch 9565/10000
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Epoch 9566/10000
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Epoch 9567/10000
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Epoch 9569/10000
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Epoch 9572/10000
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Epoch 9573/10000
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Epoch 9574/10000
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Epoch 9575/10000
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Epoch 9576/10000
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Epoch 9577/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9578/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9579/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9580/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
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0/0 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9581/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9582/10000
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Epoch 9583/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9584/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9585/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9586/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9587/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9588/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9589/10000
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Epoch 9590/10000
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Epoch 9591/10000
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Epoch 9594/10000
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Epoch 9595/10000
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Epoch 9596/10000
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Epoch 9597/10000
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Epoch 9599/10000
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Epoch 9600/10000
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Epoch 9601/10000
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Epoch 9602/10000
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Epoch 9603/10000
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Epoch 9609/10000
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Epoch 9610/10000
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Epoch 9611/10000
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Epoch 9625/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
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Epoch 9626/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9627/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0012
Epoch 9628/10000
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Epoch 9629/10000
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Epoch 9660/10000
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Epoch 9661/10000
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Epoch 9662/10000
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Epoch 9663/10000
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Epoch 9664/10000
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Epoch 9665/10000
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Epoch 9666/10000
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Epoch 9667/10000
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Epoch 9668/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9669/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9670/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9671/10000
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Epoch 9671/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9672/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9673/10000
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Epoch 9674/10000
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Epoch 9675/10000
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Epoch 9676/10000
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Epoch 9677/10000
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Epoch 9678/10000
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Epoch 9679/10000
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Epoch 9680/10000
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Epoch 9681/10000
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Epoch 9682/10000
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Epoch 9683/10000
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Epoch 9684/10000
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Epoch 9685/10000
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Epoch 9686/10000
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Epoch 9687/10000
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Epoch 9688/10000
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Epoch 9689/10000
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Epoch 9695/10000
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Epoch 9697/10000
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Epoch 9698/10000
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Epoch 9699/10000
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Epoch 9700/10000
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Epoch 9701/10000
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Epoch 9702/10000
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Epoch 9703/10000
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Epoch 9704/10000
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Epoch 9705/10000
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Epoch 9706/10000
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Epoch 9707/10000
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Epoch 9708/10000
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Epoch 9709/10000
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Epoch 9710/10000
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Epoch 9713/10000
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Epoch 9714/10000
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Epoch 9715/10000
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Epoch 9716/10000
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8/8 [=====] - 0s 4ms/step - loss: 0.0012
Epoch 9717/10000
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Epoch 9718/10000
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Epoch 9725/10000
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Epoch 9726/10000
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Epoch 9727/10000
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Epoch 9733/10000
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Epoch 9734/10000
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Epoch 9735/10000
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Epoch 9736/10000
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Epoch 9738/10000
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Epoch 9739/10000
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Epoch 9741/10000
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Epoch 9742/10000
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Epoch 9743/10000
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Epoch 9744/10000
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Epoch 9745/10000
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Epoch 9746/10000
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Epoch 9747/10000
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Epoch 9748/10000
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Epoch 9749/10000
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Epoch 9750/10000
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Epoch 9751/10000
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Epoch 9752/10000
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Epoch 9753/10000
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Epoch 9754/10000
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Epoch 9755/10000
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Epoch 9756/10000
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Epoch 9757/10000
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Epoch 9758/10000
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Epoch 9759/10000
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Epoch 9760/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9761/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
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0/0 [=====] - 0s 4ms/step - loss: 0.0012
Epoch 9762/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9763/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9764/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9765/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9766/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9767/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9768/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9769/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9770/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9771/10000
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Epoch 9772/10000
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Epoch 9773/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9774/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9775/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9776/10000
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Epoch 9777/10000
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Epoch 9778/10000
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Epoch 9779/10000
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Epoch 9780/10000
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Epoch 9781/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9782/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9783/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9784/10000
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Epoch 9785/10000
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Epoch 9786/10000
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Epoch 9787/10000
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Epoch 9788/10000
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Epoch 9789/10000
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Epoch 9790/10000
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Epoch 9791/10000
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Epoch 9792/10000
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Epoch 9793/10000
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Epoch 9794/10000
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Epoch 9795/10000
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Epoch 9796/10000
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Epoch 9797/10000
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Epoch 9798/10000
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Epoch 9799/10000
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Epoch 9800/10000
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Epoch 9801/10000
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Epoch 9802/10000
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Epoch 9803/10000
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Epoch 9804/10000
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Epoch 9805/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9806/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
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Epoch 9807/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9808/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9809/10000
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Epoch 9810/10000
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Epoch 9811/10000
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Epoch 9812/10000
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Epoch 9813/10000
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Epoch 9814/10000
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Epoch 9815/10000
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Epoch 9816/10000
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Epoch 9817/10000
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Epoch 9818/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9819/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0012
Epoch 9820/10000
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Epoch 9821/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9822/10000
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Epoch 9823/10000
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Epoch 9824/10000
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Epoch 9825/10000
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Epoch 9826/10000
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Epoch 9827/10000
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Epoch 9828/10000
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Epoch 9829/10000
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Epoch 9831/10000
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Epoch 9832/10000
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Epoch 9833/10000
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Epoch 9834/10000
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Epoch 9835/10000
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Epoch 9836/10000
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Epoch 9837/10000
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Epoch 9838/10000
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Epoch 9839/10000
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Epoch 9840/10000
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Epoch 9841/10000
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Epoch 9842/10000
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Epoch 9843/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9844/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9845/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0012
Epoch 9846/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9847/10000
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Epoch 9848/10000
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Epoch 9849/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9850/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9851/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0012
Epoch 9852/10000
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Epoch 9853/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9854/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9855/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9856/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9857/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9858/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9859/10000
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Epoch 9860/10000
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Epoch 9861/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9862/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9863/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9864/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9865/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9866/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9867/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9868/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9869/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9870/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9871/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9872/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9873/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9874/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9875/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9876/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9877/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0012
Epoch 9878/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9879/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9880/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9881/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9882/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9883/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9884/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9885/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9886/10000
8/8 [=====] - 0s 5ms/step - loss: 0.0012
Epoch 9887/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9888/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0012
Epoch 9889/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9890/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9891/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0012
Epoch 9892/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9893/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9894/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9895/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9896/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9897/10000
```

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8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9898/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9899/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9900/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9901/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9902/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9903/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9904/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9905/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9906/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9907/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9908/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9909/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9910/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9911/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9912/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0012
Epoch 9913/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9914/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9915/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9916/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0012
Epoch 9917/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9918/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0012
Epoch 9919/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9920/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0012
Epoch 9921/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9922/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9923/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9924/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9925/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9926/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9927/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9928/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9929/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9930/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0012
Epoch 9931/10000
8/8 [=====] - 0s 4ms/step - loss: 0.0012
Epoch 9932/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9933/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9934/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9935/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9936/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9937/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9938/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9939/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9940/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9941/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9942/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
```

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0/0 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9943/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9944/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9945/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9946/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9947/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9948/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9949/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9950/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9951/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9952/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9953/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9954/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9955/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9956/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9957/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9958/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9959/10000
8/8 [=====] - 0s 2ms/step - loss: 0.0012
Epoch 9960/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
Epoch 9961/10000
8/8 [=====] - 0s 3ms/step - loss: 0.0012
```